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TURF BULLETIN

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FEATURED IN THIS ISSUE:

Growth Retardant, Embark

Nitrogren Leaching Losses from N Fertilizers Applied to Turf

Research Update

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CONFERENCE ISSUE

BETTER TURF THROUGH RESEARCH AND EDUCATION

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More detailed information on the subjects discussed here can be found in bulletins and circulars or may be had through correspondence with the editor.

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RESEARCH UPDATE

Dr. William A. Torello, Ms. Anna G. Symington,
Mr. Charles F. Mancino and Ms. Elizabeth L. Clifton
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The objectives of the turfgrass research program at the University of Massachusetts are directed toward improving the efficiency of turfgrass cultural procedures and improving turfgrasses for increased tolerance towards stresses such as drought, sub-optimal temperatures, disease and low quality irrigation water high in soluble salts. Extensive research is also being conducted in determining the fate of nitrogen in turf and characterizing the physiological effects of various growth retardents. These basic objectives are similar in scope to most other turfgrass research programs. Steady cost increases in fertilizers, pesticides and irrigation as well as the seemingly increased occurrances of environmental stresses along with the reduction of water quality and quantity have stimulated a concerted nationwide research effort. The projects described in this report are currently being undertaken at the Unversity of Massachusetts. These projects, however, are only a part of a growing regional and national effort.

Nitrogen Fate Research

Intensive laboratory, field and greenhouse studies have been and are currently underway to determine the fate of topically applied nitrogen. Nitrogen leaching, uptake and the gaseous losses of N from turf over a broad range of environmental and soil characteristics are being evaluated. Emphasis is being placed upon the gaseous losses of nitrogen from turf via denitrification. This process can be the major pathway by which large amounts of applied N may be lost under certain conditions. At present, no information has been reported in turf for this process. Understanding the factors which govern losses of applied N will provide the key toward controlling or reducing these losses and thus make fertilizing more cost efficient.

Growth Retardent Research

The use of chemical growth retardents to inhibit turfgrass growth and reduce mowing frequencies has, for all practical purposes, been limited to roadside and course turf areas. Efforts are currently underway, however, to produce new chemicals and to modify the use of existing chemicals for use on fine turf areas. The problems which need attention are the detrimental side effects associated with these chemicals, especially during periods of temperature stress. Field trails and laboratory studies are currently underway with two widely used retardents; 1) root absorbed EL-500 and 2) foliar absorbed Embark. The effect of these chemicals upon the carbohydrate physiology of turfgrass is being evaluated. The effects of application timing, number of applications and temperature are being studied. Results of this study will provide information on how these chemicals predispose turf towards environemtnal stress. This pilot project will also provide the framework for further intensive research projects.

Salt Tolerance

Salt stress may be imposed upon a turf in a variety of ways: 1) by winter salt applications to roads; 2) by ocean salt-spray; 3) by sodic or naturally saline soils; and 4) by application of low quality irrigation water high in soluble salts. The last factor has been determined to be the most critical in recent years. Our water supply has been (and continues to be) increasing in soluble salt levels. A number of environmental factors are responsible. Nevertheless, continued application of these waters for irrigation can eventually become stressful. In the past two years we have screened a number of cultivars of kentucky bluegrass and red fescue for their inherent salt tolerance. Much variablility exists, with some having high tolerance, and some being intolerant. At this point we can utilize various methods for improving salt tolerance. More importantly, now that we know the level of tolerance for these cultivars, we can begin to study the physiological mechanisms responsible for salt tolerance, which may also be responsible for drought tolerance. This information would be highly beneficial to turfgrass breeders as well as for our tissue culture program in which we are trying novel approaches towards turfgrass improvement.

Turfgrass Tissue Culture

Tissue culture techniques involve the manipulation of plant genes through various procedures other than classical breeding techniques. These methods also provide unique systems for studying the physiological responses of turfgrass to most external factors. Most important, however, is that tissue culture and genetic engineering techniques can yield new types of improved turfgrasses that nature or the turfgrass breeder could not produce. In short, tissue culture can provide an extensive base of genetic variability that may enhance breeding efforts.

Over the past two years we have organized a program and equipped a laboratory devoted to the tissue culture of turfgrasses. Since virtually no research had been reported for turfgrasses in tissue culture, an enormous amount of "footwork" was necessary. However, results have been promising and we are now at a point where practical applications for genetic improvement are currently underway. A more detailed report on tissue culture of turfgrasses will be presented in a later research update. Interested readers are directed to the July 1982 and July 1983 issues of Golf Course Management for more detailed information on the tissue culture program at the University of Massachusetts.

The intention of this report was to update readers on our ongoing research projects at the University of Massachusetts. Each project and results from these studies will be reported in later issues of the Turf Bulletin.

LOW MANAGEMENT KENTUCKY BLUEGRASS CULTIVAR TRIALS

Lesley A. Spokas and Dr. Joseph Troll
University of Massachusetts/Amherst

Most Kentucky bluegrass cultivars are high nitrogen feeders. Nitrogen is expensive to produce and to purchase. With energy and cost consciousness ever increasing it is in the interest of savings to investigate cultivars which exhibit acceptable color and density while receiving low management. A low management regime could mean no more than 2 lbs actual nitrogen per 1000 sq. ft. per year, supplemental irrigation only as needed to maintain healthy turf, and reduced or no fungicide applications.

A low management kentucky bluegrass cultivar trial was initiated at the University of Massachusetts Turfgrass Research Station on September 24, 1980. Eighty-four cultivars were seeded on a silt loam soil in 4 ft. by 6 ft. plots, with each cultivar replicated three times. The trial received 2 lbs of actual nitrogen per 1000 sq. ft. each of the last two years. During the 1982 growing season the cultivars received no supplemental water. Weather conditions during the 1983 growing season required supplemental watering to maintain the stand. Fungicides were not applied in order to facilitate disease observations. Cultivars Dormie, WWAg478, A-20, and Kimono consistently rated high in 1982 (table 1). Birka, PSU-190, CEB-VB-3965, Lovegreen, Victa, and SH-2 rated above average on at least three readings. During the 1983 season PSU-190, PSU-173, Kimono, Vanessa, Sydsport and SH-2 exhibited better ratings consistently (table 2).

In 1982 cultivars BA-61-91, 225, Mystic, Admiral, Eclipse, Escort, K3-179, K3-178, K1-152, and Barblue appeared to be free of leaf spot. All cultivars had the disease in 1983 - many severely (table 2). The increased incidence and severity of leaf spot in the spring of 1983 can be attributed to reduced hardiness resulting from the low management. Due to the low level of nitrogen dollar spot was more evident in 1983; nearly every cultivar was infected. In August and September the better grass plots showed a higher incidence of the disease because there was not enough growth in the other plots to support the disease.

As the study continues it is expected that diseases will be the limiting factor in cultivar selection. Leaf spot may eliminate some cultivars in the spring of 1984. The continued low level of nitrogen will promote dollar spot, which may eliminate additional cultivars. Future results and statistical differences will be forthcoming.

Table 1 Performance of Kentucky bluegrass cultivars - 1982.

Cultivar	5/3	6/3	7/1	8/10	9/24	10/28	Avg.	Cultivar	5/3	6/3	7/1	8/10	9/24	10/28	Avg.
Adelphi	1.6*	2.3[1]	2.6	3.0	2.6	3.3	2.6	WW Ag 478	1.6	4.6[1]	5.3	5.3[2]	5.0	4.0	3.7
Glade	2.6	2.6[1]	4.0	4.6	4.3	4.6	3.8	Piedmont	3.0	2.3[1]	2.0	4.0	4.0	4.6	3.3
Birka	2.6	4.3[1]	4.6	5.3	4.3	4.0	4.2	Majestic	2.3	3.0[1]	4.0	4.3[2]	3.6	4.6	3.6
Monopoly	2.6	3.0[1]	3.0	4.0[2]	4.3	4.3	3.5	Bonnieblue	2.3	3.3[1]	3.3	4.0	3.3	4.0	3.4
Ram-I	2.6	4.0[1]	3.6	4.6	4.6	4.3	4.0	Vantage	2.3	2.0[1]	2.6	3.3	3.6	4.3	3.0
Fylking	2.3	3.6[1]	4.6	4.0	3.6	4.3	3.7	Merit	2.6	3.6[1]	4.3	4.6	4.6	5.0	4.1
Cheri	2.6	4.0[1]	4.6	3.6[2]	3.3[2]	4.0	3.7	Argyle	2.6	2.0[1]	2.3	3.0	3.0	3.3	2.7
243	2.3	2.5[1]	3.6	3.6	3.3	4.0	3.2	Charlotte	2.0	3.0[1]	4.3	4.6[2]	4.0	4.3	3.7
Wabash	2.6	2.6[1]	2.3	4.0	4.3	4.0	3.3	A-20-6	2.3	3.3[1]	4.0	4.3	4.6	4.3	3.8
Nugget	1.3	3.0[1]	3.6	4.3[2]	4.0[2]	3.6	3.3	A20	2.3	4.0[1]	5.0	5.0[2]	4.6	4.3	4.2
239	2.3	2.6[1]	3.6	4.0	3.6	3.3	3.2	H-7	2.0	3.6[1]	4.3	3.6	3.3	4.3	3.5
S-21	3.0	3.0[1]	2.3	2.3	3.0	3.6	2.9	I-13	2.6	3.3[1]	4.0	4.6	4.6	4.0	3.9
PSU-190	3.0	3.5[1]	5.3	4.6[2]	4.3	4.6	4.2	A20-6A	1.6	2.6[1]	4.0	4.0	3.0	4.6	3.3
PSU-150	3.3	3.0[1]	4.0	4.3	4.0	4.3	3.8	N535	2.3	3.3[1]	4.0	4.0	4.3	4.0	3.7
PSU-173	2.3	2.6[1]	4.3	5.0	4.3	4.3	3.8	1528T	2.0	4.0[1]	4.3	4.0[2]	3.3[2]	3.6	3.5
Kimono	2.3	4.0[1]	5.0	4.6[2]	4.6	4.6	4.2	Shasta	2.6	3.3[1]	3.6	4.3	4.6	4.6	3.8
Baron	2.0	3.6[1]	4.3	5.3[2]	4.3	4.3	4.0	Columbia	2.3	3.6[1]	4.0	4.3	3.3	4.0	3.6
Enmundi	2.3	3.0[1]	4.3	5.0[2]	4.6	4.0	3.7	Apart	3.0	3.3[1]	4.3	3.3	3.6	5.0	3.8
Plush	2.0	3.0[1]	3.0	4.0[2]	4.0	3.6	3.3	A-34	2.0	2.6[1]	3.3	4.0	3.3	4.3	3.3
Parade	2.0	2.3[1]	3.3	4.0	4.3	3.3	3.2	Sydsport	2.6	3.3[1]	5.0	4.6[2]	4.3	5.0	4.2
Trenton	2.0	3.3[1]	4.0	4.0	4.6	4.3	3.7	Mer pp 300	2.3	3.0[1]	4.3	4.3	5.0	5.0	4.0
Rugby	2.3	3.0[1]	3.3	3.3	3.6	4.0	3.3	Mer pp 43	3.0	2.0[1]	3.3	4.0	3.6	4.0	3.3
SU-01617	2.0	2.3[1]	4.0	4.6	4.0	5.0	3.7	Mona	2.3	3.6[1]	4.3	4.3	3.6	4.3	3.7
Banff	2.6	4.3[1]	4.6	3.6	3.3	4.0	3.7	Lovegreen	2.0	3.0[1]	4.3	5.0	4.6	4.6	3.9
Dormie	2.6	4.3[1]	5.3	5.0[2]	3.0	5.0	4.2	Bristol	2.3	2.6[1]	4.6	3.6[2]	3.0	4.0	3.4
Holiday	2.0	2.3[1]	4.0	3.6	3.3	4.3	3.3	Victa	2.6	4.0[1]	4.3	5.0	4.3	4.6	4.1
Geronimo	2.6	3.3[1]	4.3	5.3	4.3	4.6	4.0	Enoble	2.3	4.0[1]	4.3	4.3	4.3	4.0	3.9
Aspen	2.0	3.0[1]	3.6	4.0	3.3	3.6	3.3	SH-2	3.0	3.6[1]	3.6	4.3	4.6	4.6	4.0
MLM-18011	2.0	2.6[1]	3.6	5.0	4.3	4.3	3.6	NJ 735	2.0	3.3[1]	4.3	4.0	3.6	3.3	3.4
CEB VB 3965	2.3	3.0[1]	4.3	5.0	5.0	4.6	4.0	S.D. Common	3.0	2.0[1]	2.0	2.3	2.6	3.6	2.6
Touchdown	2.3	2.6[1]	3.6	4.6[2]	4.6	3.6	3.6	Merion	2.3	2.6[1]	3.6	4.6	3.3	3.3	3.3
Welcome	2.3	2.6[1]	3.3	4.6	4.0	4.3	3.5	BA-61-91	2.6	3.6	4.6	5.0[2]	4.3	4.6	4.1
WW Ag 463	2.0	3.0[1]	3.6	4.3	3.6	4.3	3.5	Bayside	3.0	2.6[1]	3.0	3.6	4.0	4.0	3.4
WW Ag 480	2.0	4.0[1]	4.3	5.0	4.3	3.3	3.8	225	2.6	3.0	4.0	4.3	3.6	4.0	3.6
Bono	2.3	4.0[1]	4.0	4.6	4.3	4.0	3.9	P141 (Mystic)	2.3	3.3	3.3	4.3[2]	4.0[2]	4.3	3.6
Kenblue	3.0	2.0[1]	2.0	3.0[2]	2.3	2.6	2.5	Admiral	2.3	2.6	4.3	3.3	3.3	4.0	3.3
Harmony	2.0	2.6[1]	3.0	4.3	4.0	4.3	3.7	Escort	2.6	3.0	4.6	4.3[2]	4.0	4.6	3.9
American	2.0	3.3[1]	4.0	4.6	4.3	4.6	3.7	K3-162	3.0	3.3[1]	3.0	3.6	3.3	4.0	3.4
Vanessa	2.6	3.3[1]	4.0	4.6	4.3	3.6	3.9	K3-179	1.6	3.6	2.0	3.0	2.6	4.0	2.8
Mosa	2.6	3.6[1]	3.3	4.3[2]	4.3	4.0	3.7	K3-178	3.0	3.6	4.0	3.6	3.6	5.0	3.8
Cello	2.6	3.0[1]	4.3	5.3[2]	4.6	3.6	3.5	K1-152	2.0	2.6	3.3	3.0	2.6	4.0	2.9
Eclipse	1.6	3.0	3.3	4.0	4.0	3.3	3.2	Barblue	1.6	3.3	3.3	4.0	3.3	4.0	3.3

1 = Helminthosporium
2 = Dollar spot

* Quality ratings were based on color and density on a scale of 1 - 9, with 9 representing ideal turf and 1 no turf.

Table 2 Performance of Kentucky bluegrass cultivars - 1983.

Cultivar	4/13	5/13	6/13	7/12	8/7	9/12	10/6	Avg.
Adelphi	2.0*	2.0	3.3	4.3[2]	3.3	3.0	3.3	3.0
Glade	2.7	2.7	4.3	5.7	4.0	4.0	4.3	4.0
Birky	2.3	2.7	4.3	4.3[2]	3.0	3.0	3.7	3.3
Monopoly	2.3	3.0	4.0	4.0[2]	3.3	3.7	4.7	3.6
Ram I	2.3	3.0	4.0	4.3[2]	3.7	2.7	3.7	3.4
Fylking	2.0	3.3	4.3	5.0[2]	4.3	3.7	4.3	3.8
Cheri	2.0	3.0	3.7	4.3[2]	3.3	3.7	4.3	3.5
243	2.3	3.7	3.7	2.7[2]	2.0	2.3	2.7	2.8
Wabash	2.3	1.3[1]	2.7	3.7[2]	3.3	3.7	3.7	3.0
Nugget	2.0	3.7	4.0	5.7[2]	3.3	3.0	4.0	3.7
239	2.0	2.3	3.0	2.7[2]	2.0	1.7	3.0	2.1
S-21	2.7	1.0[1]	2.0	2.7[2]	2.7	3.0	3.7	2.5
PSU-190	2.7	3.7	4.0	6.0[2]	4.7	4.3	5.3	4.4
PSU-150	2.3	3.0	3.7	5.7	4.3	4.3	4.7	4.0
PSU-173	2.7	3.0	4.0	5.7	4.7	4.7	5.3	4.3
Kimono	2.7	3.7	5.0	6.3	4.7	4.7	4.7	4.5
Baron	2.3	3.0	3.7	4.7	3.0	3.0	4.0	3.4
Enmundi	2.3	3.0	4.7	4.7	3.3	3.3	4.3	3.7
Plush	2.3	2.3[1]	3.7	5.3[2]	4.7	4.3	5.3	4.0
Parade	2.0	1.7[1]	2.7	3.0[2]	2.0	2.7	3.0	2.4
Trenton	2.3	3.0	4.0	4.3[2]	2.3	2.3	3.7	3.1
Rugby	2.3	3.0	3.3	3.0[2]	2.0	2.0	2.7	2.6
SU-01617	3.0	3.3	4.7	6.0[2]	4.0	4.3	4.7	4.3
Banff	2.7	2.3	3.0	3.3[2]	2.3	2.3	3.0	2.7
Dormie	2.3	3.3	5.0	4.7	4.7	4.0	4.3	4.0
Holiday	2.3	2.7	3.7	4.7	3.3	3.0	4.3	3.7
Geronimo	2.7	3.3	4.0	6.0	4.7	4.3	5.3	4.3
Aspen	3.0	3.3	3.7	5.0[2]	2.7	3.0	4.7	3.6
MLM-18011	3.7	3.7	4.3	4.7	3.3	3.3	4.7	4.0
CEB VB 3965	2.7	3.7	4.7	5.7	3.3	3.0	4.0	3.9
Touchdown	2.3	3.0	4.3	5.7[2]	3.3	3.3	5.0	3.8
Welcome	2.3	2.7	3.3	5.0[2]	5.0	4.7	5.7	4.1
WW Ag 463	2.0	3.0[1]	3.7	4.7[2]	2.3	2.7	3.7	3.2
WW Ag 480	2.7	2.7	4.3	5.3[2]	3.3	3.7	4.0	3.7
Bono	2.7	2.3	3.0	4.0[2]	2.7	2.7	3.0	2.9
Kenblue	2.0	1.0[1]	2.0	3.3[2]	2.7	2.3	3.3	2.4
Harmony	2.7	1.7[1]	3.0	4.7	4.3	5.0	6.3	4.0
American	2.3	3.3	4.0	4.7	4.3	4.0	5.0	4.0
Vanessa	2.7	3.0	4.3	6.7	5.3	4.3	5.7	4.6
Mosa	2.3	3.0	4.0	5.0	4.3	3.7	4.7	3.9
Cello	2.0	2.3	3.7	5.3[2]	4.0	3.7	4.7	3.7
Eclipse	2.3	2.7	4.0	4.7	4.3	4.3	4.3	3.8

Cultivar	4/13	5/13	6/13	7/12	8/7	9/12	10/6	Avg.
WW Ag 478	2.0	4.0	4.3	5.3	4.7	3.7	4.7	4.1
Piedmont	2.3	1.0[1]	2.0	3.3[2]	4.0	3.7	5.0	3.0
Majestic	2.3	3.0	3.7	3.7[2]	3.3	3.0	4.7	3.4
Bonnieblue	2.7	3.3	4.3	4.0[2]	2.3	2.0	3.3	3.1
Vantage	2.3	1.0[1]	2.0	3.7[2]	3.7	3.7	5.0	3.1
Merit	3.3	3.0	4.0	6.3[2]	4.3	4.0	4.7	4.2
Argyle	2.0	1.0[1]	2.0	3.0[2]	3.7	2.7	3.7	2.6
Charlotte	2.3	3.0	3.3	5.0	4.3	4.0	5.0	3.8
A-20-6	2.3	3.7	5.0	4.3[2]	2.7	2.7	4.0	3.5
A20	2.7	3.3	4.3	5.3	3.3	3.3	4.3	3.8
H-7	2.3	4.3	5.0	4.3[2]	2.7	2.7	4.0	3.0
I-13	2.3	2.7	4.0	4.7[2]	3.0	3.0	4.7	3.5
A20-6A	2.3	2.7	4.0	4.0[2]	3.0	3.0	4.0	3.3
N535	2.7	3.3	4.7	4.3[2]	3.3	2.3	4.7	3.6
1528T	2.3	2.7	3.7	3.0[2]	2.7	2.3	3.7	2.9
Shasta	3.0	3.7	4.0	4.3[2]	3.3	3.0	5.0	3.8
Columbia	2.7	2.7	3.7	4.3	3.0	3.0	3.7	3.3
Apart	2.3	2.7	3.0	4.3[2]	3.7	3.3	5.0	3.5
A-34	2.7	2.3	4.0	4.0	3.0	3.3	5.0	3.5
Sydsport	2.3	3.7	4.3	6.0	5.0	4.3	5.3	4.4
Mer pp 300	2.7	3.0	4.3	4.7[2]	3.7	4.3	5.0	4.0
Mer pp 43	2.3	1.3[1]	2.0	4.0[2]	4.0	4.0	5.7	3.3
Mona	2.3	3.0	3.3	4.7	3.0	2.7	4.0	3.3
Lovegreen	3.0	2.3	2.7	4.0[2]	4.7	4.3	5.3	3.8
Bristol	2.3	3.0	3.7	3.0[2]	2.3	3.0	3.7	3.0
Victa	2.7	2.7	4.0	5.0	4.0	3.3	4.7	3.8
Enoble	2.3	3.0	3.7	4.7[2]	2.3	3.3	5.0	3.5
SH-2	2.7	3.3	4.3	6.0[2]	4.7	4.0	5.3	4.3
NJ 735	3.0	3.7	4.7	4.7[2]	3.3	3.0	3.7	3.7
S.D. Common	2.0	1.0[1]	2.0	2.7[2]	3.0	2.7	4.0	2.5
Merion	2.3	3.0	3.7	4.0[2]	2.0	2.7	3.7	3.1
BA-61-91	2.7	3.0	4.0	3.3	3.0	4.0	4.7	3.5
Bayside	2.3	3.7	2.0	3.7	3.3	3.0	5.3	3.3
225	2.7	3.3	4.0	4.3	2.7	3.0	4.0	3.4
P141 (Mystic)	2.7	2.3[1]	2.7	4.3	5.3	4.7	5.0	3.9
Admiral	2.0	3.3	3.7	3.3[2]	2.7	2.3	4.7	3.1
Escort	2.7	4.0	4.0	5.3	3.7	3.0	4.3	3.9
K3-162	2.0	1.0[1]	2.0	3.3	4.7	5.0	5.7	3.4
K3-179	2.3	1.7[1]	2.3	4.3	4.0	4.3	5.0	4.0
K3-178	2.3	2.7	4.0	3.3[2]	2.0	3.0	4.0	3.4
K1-152	2.3	2.7	3.7	3.3	2.7	3.0	4.3	3.1
Barblue	2.3	2.7	4.3	3.7	3.3	3.3	4.3	3.4

1 = Severe Helminthosporium (sp) infestation
2 = Dollar spot

*Quality ratings were based on color and density on a scale of 1 - 9, with 9 representing ideal turf and 1 no turf.

NITROGEN LEACHING LOSSES FROM N FERTILIZER APPLIED TO TURF

Charles F. Mancino and Dr. Joseph Troll
University of Massachusetts/Amherst

Nitrogen is lost from applied fertilizers in several ways. Nitrogen gasses are released into the atmosphere as a result of soil microbial processes. Further losses occur when nitrogen is fixed by the soil's organic and mineral fractions. Leaching accounts for the remainder of the lost nitrogen. These losses are greatly affected by soil and climatic conditions, and are therefore of interest to both fertilizer applicators and environmentalists. Environmentalists' concern applies to nitrogen lost by leaching, as a potential health hazard, and as a contributor to surface water pollution due to eutrophication. Those who use fertilizers are more concerned with efficiency and economic losses. Research is currently being done to provide an understanding of the processes occuring during nitrogen loss.

Experiments to determine nitrogen concentrations in soil leachate collected from the root zone of turf were conducted at the University of Massachusetts Turf Research Center in South Deerfield, Massachusetts. This research was carried out on three different soil types: an 80%-20% sand:peat soil, a sandy loam soil and a silt loam soil. The sand:peat soil supported a "Penncross" creeping bentgrass turf which was maintained at 0.25 inches, mowed three times weekly, clippings removed. Irrigation was 1.5 inches per week applied in three 0.5 inch waterings. Fast-release fertilizers applied included urea, calcium nitrate, ammonium nitrate and ammonium sulfate. Slow-release fertilizers UF and IBDU completed the studied fertilizers. Rates of nitrogen application were either 0.2 lb N/100 sq. ft. every seven days or 0.4 lb N/1000 sq. ft. every 14 days, to total 6 lbs N/1000 sq. ft./year. Turf quality and growth on the sand:peat soil were influenced by N fertilizer type. Fast-release N sources produced acceptable turf within four weeks after fertilizer application initiation. Slow-release N sources did not result in satisfactory quality or growth. Leachate samples were taken weekly. The maximum N03- concentration found in the soil leachate from any of the treated plots was 7.01 ppm. This level was not significantly different from the control plots which had no nitrogen applied. At the end of the 1982 season a one time application of 1 lb N/1000 sq. ft. was made to determine if this would affect N03- concentrations in the leachate. Only the calcium nitrate treated plots resulted in N03- levels which were higher than those of the control plots, but these were minimal.

The second and third sets of plots were on a silt loam and a sandy loam soil respectively. These plots contained an established bluegrass-fescue-bentgrass sod which was maintained under fairway conditions. The turf was mowed at 0.5 inches three times weekly, and clippings were not collected. Supplemental irrigation was used to maintain healthy grass only. Fertilizers applied on these soils were urea, sulfur-coated urea, methylene urea and UF. Rates of application were 2 lb N/1000 sq. ft/season and 4 lb N/1000 sq. ft/season. Applications were made in June and September in 1981, June and July 1982. Turf quality and growth on the silt loam was greater for all plots than on the sandy loam soil. The grass on the sandy loam soil did, however, respond favorably to all N treatments, especially at the 4 lb N/1000 rate. Leachate samples were collected weekly. For these soil types no differences were found between the treated plots and the control plots. Rate of application did not influence N03- concentration in the soil leachate.

Nitrogen leaching losses from fertilizers applied to turf may be minimized when applied at the rates used in this study. These rates are comparable to those used on New England golf courses. In practical application it seems reasonable to assume that the economic losses of nitrogen by leaching can be small. From an environmental standpoint, these fertilizers and rates posed little threat to human health by surface or ground water pollution.

PROGRAM

53rd MASSACHUSETTS TURFGRASS CONFERENCE and 8th INDUSTRIAL SHOW

"Dedication to Mr. Arthur E. Anderson and Prof. John M. Zak for Outstanding Devotion and Service to the Turf Profession"

February 28, 29, March 1, 1984 Civic Center Springfield, Massachusetts
(I-91, Exit 6 from South, Columbus Avenue Exit from North)

Sponsored by Department of Plant & Soil Sciences, University of Massachusetts/Amherst
Massachusetts Turf & Lawn Grass Council
Golf Course Superintendents Association of New England

REGISTRATION
Lobby - Banquet Hall Entrance

8:30 AM-4:00 PM Tuesday, February 28
8:00 AM-4:00 PM Wednesday, February 29

TUESDAY, FEBRUARY 28

—Morning—

9:00 AM-12:45 PM Industrial Show Open
Exhibition Hall. Snack Bar

—Afternoon—

GENERAL SESSION
Banquet Room

Chairman: Dr. Joseph Troll
Dept. of Plant & Soil Sciences
University of Massachusetts/Amherst

1:00 Welcome
Dr. David E. Leonard, Acting Dean College of Food & Natural Resources, University of Massachusetts/Amherst

1:15 Ecological Principles of Turf Management
Dr. Donald B. White, Dept. of Horticultural Science & Landscape Architecture, University of Minnesota, St. Paul, MN

1:45 Computer Operations Simplified
Dr. David Wilcock, Dept. of Food & Resource Economics, University of Massachusetts/ Amherst

2:15 Applying the Computer to Your Golf Course Management Operations
Mr. Robert E. Grant, Supt., Brae Burn Country Club, West Newton, MA

2:45 PM-3:00 PM Break

3:00 Little Things You Can Do at Your Club to Secure Your Future
Mr. Stanley Zontek, Director, North-Central Region, USGA Green Section, Crystal Lake, IL

3:45 The Role of the Superintendent in Knowing How to Play Golf
Mr. Paul Miller, Supt., Tedesco Country Club, Marblehead, MA

4:30 PM-6:30 PM Industrial Show Open
Exhibition Hall

WEDNESDAY, FEBRUARY 29

GOLF COURSE SESSION
Banquet Room

—Morning—

Chairman: Prof. John M. Zak
Dept. of Plant & Soil Sciences
University of Massachusetts/Amherst

9:00 Stress and the Golf Course Superintendent/ Basic Survival
Mr. William Smart, Supt., IBM Country Club, Poughkeepsie, NY

9:45 Endomycorrhizal Fungi . . . Friend or Foe?
Dr. A. Martin Petrovic, Dept of Floriculture & Ornamental Horticulture, Cornell University, Ithaca, NY

10:30 Insect Control in Golf Course Turf
Dr. Paul Heller, Dept. of Entomology, Pennsylvania State University, University Park, PA

11:00 AM-2:00 PM Industrial Show Open
Exhibition Hall

—Afternoon—

2:00 Compaction Effects on Nitrogen Fertilization
Dr. Robert N. Carrow, Dept. of Horticulture & Forestry, Kansas State University, Manhattan, KS

2:30 Turflife - A New Fertilizer for Lawns and Golf Courses
Dr. William Mitchell, Plant Science Dept., University of Delaware, Newark, DE

3:00 Endophytes in Turf Species
Dr. Leah Brilman, Director of Research, Jacklin Seed Co., Post Falls, ID

3:45 Cool, Warm, and Hot Turf Management
Mr. William Emerson, Supt., Paradise Valley Country Club, Paradise Vallley, AZ

4:30 PM-6:30 PM Industrial Show Open
Exhibition Hall

—Evening—

7:00 Banquet and Winter School Ceremony
"ESP in Action"
Mr. Russ Burgess, American Program Bureau, Chestnut Hill, MA

WEDNESDAY, FEBRUARY 29

ALTERNATE SESSION
College Room

—Morning—

Chairman: Mr. Charles Mruk, Agonomist, American Aqua-Tec Inc. N. Andover, MA

9:00 The Politics of Landscape Horticulture
Dr. Eliot C. Roberts, Director, The Lawn Institute, Pleasant Hill, TN

9:30 Follow-up Responsibilities after Lawn-Care Service
Dr. Charles Darrah, III, ChemLawn Corp., Columbus, OH

10:00 Tour of the Norfolk Botanical Gardens
Mr. Robert Matthews, Norfolk Botanical Gardens, Norfolk, VA

10:30 Diagnosing Lawn Problems
Ms. Maria Cinque, Nassau Country Cooperative Extension Service, Plainview, NY

11:00 AM-2:00 PM Industrial Show Open
Exhibition Hall

—Afternoon—

2:00 Meeting the Agronomic Demands of N.F.L. Football and Network Television
Dr. John R. Hall, III, Dept of Agronomy, Virginia Polytechnic Institute & State University, Blacksburg, VA

2:45 Renovating the Los Angeles Coliseum for the Olympics
Dr. Henry W. Indyk, Dept. of Soils & Crops, Rutgers University, New Brunswick, NJ

3:30 Developing an All-Weather Athletic Field From the Bottom Up
Mr. Ralph White, Vice President, Southern Turf Nurseries, Tavares, FL

4:30 PM-6:30 PM Industrial Show Open
Exhibition Hall

THURSDAY, MARCH 1

—Morning—

9:00 AM-10:00 AM Industrial Show Open
Exhibition Hall

GOLF COURSE SESSION
Banquet Room

Chairman: Dr. William A. Torello
Dept. of Plant & Soil Sciences
University of Massachusetts/Amherst

10:00 Late Season Nitrogen Fertilization
Dr. Donald B. White, Dept. of Horticultural Science & Landscape Architecture, University of Minnesota, St. Paul, MN

10:30 Irrigation Scheduling with the Infared Thermometer
Dr. Robert N. Carrow, Dept. of Horticulture & Forestry, Kansas State University, Manhattan, KS

11:00 Turf Fungicides: Theory and Use
Ms. Patricia L. Sanders, Senior Research Associate, Pennsylvania State University, University Park, PA

11:30 Irrigation - How Much Is Too Much?
Mr. James Snow, Director, Northeast Region, USGA Green Section, Far Hills, NJ

☆ ☆ ☆ ☆ ☆

LIQUID VERSUS DRY NITROGEN FERTILIZER APPLICATIONS ON KENTUCKY BLUEGRASS

Lesley A. Spokas and Dr. Joseph Troll
University of Massachusetts/Amherst

A liquid versus dry nitrogen source fertilizer study was initiated in June 1982 on an established bluegrass - fescue turf. The stand was mowed twice weekly at 1½". During the 1982 growing season supplemental irrigation was not applied. Weather conditions were more extreme in 1983 and irrigation of ½"/week was required during July, August and September to maintain a healthy sod. Fertilizer variables include five dry nitrogen fertilizers, and five liquid fertilizers. Time and rate of fertilizer application varied. Monthly quality readings were initiated in July of 1982. Results have been primarily predictable. All fast-release fertilizers showed immediate results, receiving a higher quality rating the month following an application. Plots treated with Powder Blue in suspension and UF applied dry exhibited noticeable results only during warm weather. Throughout the 1983 season the higher average temperature caused burning of the grass on the plots treated with either dry or liquid urea. Based on yearly averages for eacher fertilizer the B regime (Table 1) 0.85 lb N/1000 in April and June and 1.15 lb N/1000 in May and August, appears to be the most effective. Results are shown in Table. 2.

Table 1

Nitrogen Source — Application Time and Rate	
Source	Dry: Urea, SCU, IBDU, Scott's, UF
	Liquid: Urea, Formulene (30-0-2), Old Fox (12-0-6), Fluff, Powder Blue
Application Time and Rate	
A.	1 lb. N/1000 sq. ft. in April and June & 2 lbs. in September.
B.	0.85 lb. N/1000 sq. ft. in April and June & 2 lbs. in September.
C.	1 lb. N/1000 sq. ft. in May and September.
D.	0.5 lb. N/1000 sq. ft. in June, 1 lb. in September, and 1.5 lbs. in November

Dear Readers:

As the new editor of the Turf Bulletin I would like to take this opportunity to express a few thoughts. First I would like to thank Mr. Charles Mancino for his invaluable assistance in the preparation to this issue. Secondly, please feel free to contact me with suggestions for future issues or questions pertaining to any articles which have already been printed. The University of Massachusetts has vast resources available to all who inquire, and we are more than willing to be of assistance to you. Lastly, I would appreciate reader response on the following: should we have a letters to the editor column - or a readers forum? All correspondence is welcome, and will be answered. Remember the Turf Conference, Feb. 28, 29 and March 1. See you in Springfield.

Lesley A. Spokas

Table 2

Performance of Liquid vs. Dry Nitrogen Fertilizers on a Kentucky Bluegrass: Red Fescue Stand

	1982					1983							
Treatment	7/13	8/5	9/17	10/28	Avg	4/13	5/13	6/13	7/11	8/7	9/13	10/6	Avg
Dry													
Urea A	5.6*	6.3	5.0	6.3	5.8	4.0	7.0	7.7	7.7	5.7	8.0	8.7	7.0
B	8.0	6.7	6.0	6.3	6.7	4.7	7.0	8.3	7.7	5.7	8.7	8.0	7.2
C	7.3	5.7	4.7	6.7	6.0	4.7	5.0	7.0	6.3	5.3	7.0	8.3	7.2
D	5.7	5.7	4.7	6.7	5.6	5.3	6.3	6.7	7.0	5.7	7.7	8.7	6.8
SCU A	5.0	5.6	5.0	6.3	5.4	4.0	7.0	7.7	6.0	4.7	6.0	8.0	6.2
B	7.3	6.0	5.3	7.0	6.4	4.3	5.7	7.0	7.7	6.3	8.7	8.7	6.9
C	6.7	5.7	4.7	6.3	5.7	4.7	4.7	6.7	6.7	5.0	5.3	8.3	5.9
D	5.0	5.3	5.0	6.0	5.3	5.3	6.0	6.3	6.3	4.7	6.3	8.3	6.2
IBDU A	4.3	4.3	4.3	6.7	4.8	4.7	5.3	7.3	6.0	5.0	6.3	8.0	6.1
B	6.3	5.7	5.3	6.7	5.3	5.0	6.0	6.3	7.3	6.3	7.0	8.0	5.6
C	5.7	5.7	5.7	7.3	6.0	5.0	5.7	6.0	7.0	5.3	6.7	7.7	6.2
D	4.3	5.0	5.0	6.7	5.2	5.7	6.0	5.7	6.3	4.3	5.3	7.7	5.9
Scott's A	5.7	5.0	4.7	5.3	5.1	4.0	5.0	7.0	6.7	5.7	6.0	7.7	6.0
B	8.0	6.7	5.7	6.3	6.6	5.3	5.7	7.0	7.7	6.0	6.7	7.3	6.4
C	7.3	6.3	4.7	6.3	6.1	5.0	5.0	7.7	5.7	5.3	6.3	8.7	6.2
D	5.7	5.7	5.3	7.0	6.2	5.0	5.7	6.3	5.3	5.7	6.7	8.3	6.1
UF A	4.7	4.3	4.7	4.7	4.5	3.0	3.7	6.0	7.7	4.0	5.7	7.3	5.3
B	6.0	6.3	4.7	5.0	5.4	3.7	5.7	7.0	6.0	4.7	5.3	7.7	5.7
C	6.0	5.7	4.7	5.7	5.3	4.3	3.7	5.3	5.0	4.3	6.3	8.3	5.3
D	6.0	5.7	4.3	5.7	5.4	4.3	6.0	7.3	5.3	3.7	5.0	7.0	5.5
Liquid													
Urea A	6.3	6.0	4.7	7.7	6.1	4.3	6.7	7.0	7.0	5.3	5.3	7.3	6.1
B	8.0	6.0	5.3	7.0	6.6	4.3	6.7	8.0	7.7	6.7	6.7	8.3	6.9
C	7.3	5.7	4.7	8.0	6.4	5.0	5.3	7.0	5.7	4.7	5.7	8.3	5.9
D	6.3	5.0	4.3	7.3	5.7	6.0	5.7	6.0	5.3	5.3	5.7	8.0	6.0
Formulene A	5.3	5.7	4.3	7.3	5.6	5.3	5.7	7.7	5.7	4.7	5.0	7.0	5.9
B	5.3	5.7	5.3	6.3	5.5	5.0	5.0	6.0	6.7	5.3	4.0	7.3	5.6
C	4.3	5.3	4.7	7.0	5.3	4.7	5.0	6.7	3.7	4.3	4.3	6.7	5.1
D	6.0	6.0	4.3	6.7	5.7	6.0	5.3	5.7	6.0	5.0	5.3	6.7	5.7
Old Fox A	5.3	5.3	5.0	6.7	5.5	4.0	5.0	6.0	6.3	4.3	6.7	6.7	5.6
B	6.0	5.6	4.7	5.7	5.4	4.7	6.7	7.3	5.7	5.7	6.3	8.0	6.3
C	6.3	6.0	5.0	7.7	6.2	4.3	5.0	5.7	5.7	4.7	6.7	7.7	5.7
D	6.3	5.0	4.7	6.7	5.6	6.0	6.0	6.0	5.0	4.3	5.3	7.7	5.8
Fluff A	6.0	5.0	5.0	6.7	5.6	4.0	5.7	6.3	6.0	5.0	5.7	8.0	5.8
B	7.3	5.7	4.3	5.7	5.7	4.7	6.0	7.3	6.7	5.3	5.7	7.0	6.1
C	6.7	6.0	4.3	7.3	6.0	5.0	5.3	6.3	5.3	3.7	5.0	6.0	5.2
D	5.3	4.7	4.0	6.0	4.9	5.3	7.0	6.0	5.3	4.3	5.3	7.0	5.7
Powder Blue A	5.7	5.7	4.7	6.3	5.5	4.0	5.3	6.7	6.0	5.3	5.7	6.7	5.7
B	5.7	5.3	5.0	5.7	5.3	4.0	5.7	7.0	5.3	4.3	4.3	6.3	5.3
C	6.7	6.0	4.3	7.3	6.0	4.3	4.3	6.0	5.3	4.0	4.7	6.7	5.0
D	5.3	4.7	4.0	6.0	4.9	4.3	4.7	5.3	5.0	3.0	4.0	6.7	4.7

* Quality ratings were based on a scale of 1 through 9, with 1 = poorest, 9 = best.

In June of this year, Professor John M. Zak will be retiring from the faculty of the University of Massachusetts. As many of you readers know Prof. Zak has taught soils courses here at the university for a good many years, as well as being principal investigator of much research in roadside turf. Prof. Zak has been a friend and mentor to many Stockbridge, University and Winter School graduates, and I know that you join with me in wishing him all the best in the future.

Turf Field Day, 1984

Mark it on your calendar! Turf Field Day will be held on Wednesday, June 27 at the University of Massachusetts Turf Research Station in South Deerfield. Rain date is Thursday, June 28. Last year 250 people form throughout the Northeast attended for a tour of the research station and an explanation of the types of research being conducted. The tour will be followed by lunch and informal discussion at the top of Mt. Sugarloaf.

GROWTH RETARDANT, EMBARK

Prof. John M. Zak,
University of Massachusetts/Amherst

Chemical growth suppressants have been used along Massachusetts highways for the suppression of grass growth to eliminate mowing. Most of these chemicals have given erratic results. However, it is possible that some chemical will be developed that is satisfactory for the control of grass growth not only along highways, but also on lawns and golf course fairways.

D. James Morre[1], working for the state of Indiana, has investigated chemical mowing of grass along highways over a period of years. He has come up with a combination of chemicals, growth suppressant, herbicide and surfactant that is environmentally safe, doesn't weaken the root system and needs to be applied only once every year.

In the spring of 1983 an experiment was established using Morre's formula, specifcally the growth regulator Embark, the herbicide 2,4-D and an additive XM-12S, a surfactant. These chemicals were combined as follows: ⅔ gallon of Embark, containing 2 pounds active ingredient Mefluidide per gallon, plus 1 gallon of 2,4-D amine, containing 3.8 pounds of acid equivalent per gallon, and 1 gallon of the additive XM-12S. The chemical mixture is combined with 100 gallons and applied at 40 gallons per acre. Two areas, one "Barron" Kentucky bluegrass and the other "Kentucky-31" tall fescue were treated with the recommended rate, ½ the recommended rate and twice rhe recommended rate to evalutate this mixture on grass suppression in Massachusetts.

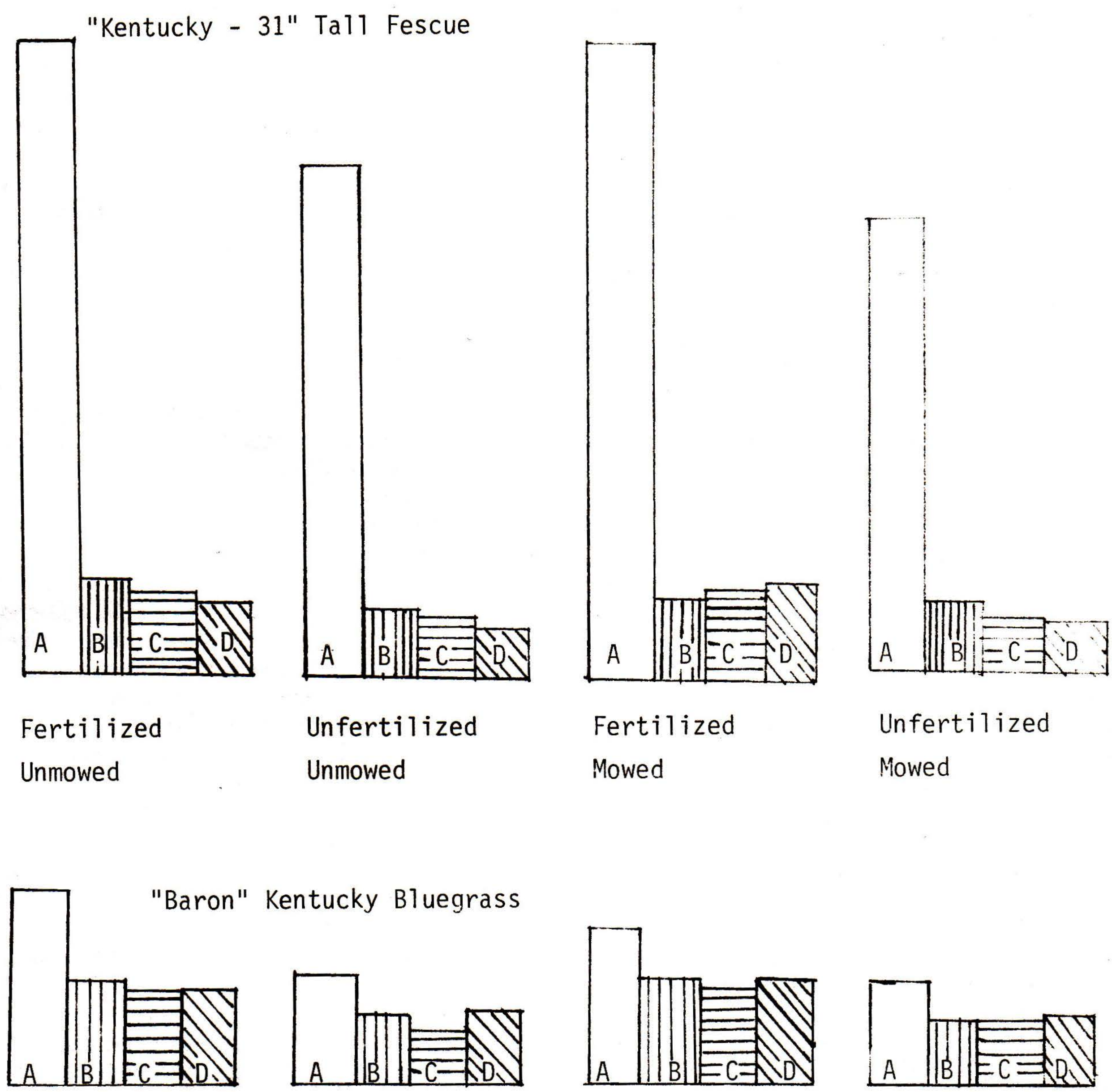
Twelve 10 ft. × 10 ft. plots were laid out for each grass type. A split plot design in both directions was used to incorporate mowed and unmowed, fertilized and unfertilized plots within the main plot. A 10-10-10 fertilizer was applied to give the equivalent of 1 pound of nitrogen per 1000 sq. ft. The fertilizer was applied on April 15, 1983. The half plots which were mowed prior to chemical application were mowed on April 29. The three rates of chemicals were applied on May 5. Application was late due to a rainy season. The height of plant growth was measured on June 6 to determine the amount of growth suppression when compared to the check.

The graph shows the amount of suppression to be about 80% for "Kentucky-31" tall fescue and about 45% for "Baron" Kentucky bluegrass. There were little or no differences in suppression of grass growth between the three treatments when compared to the check. The height of the grass remained about the same in all treated plots until mowed in late August. Fertilizing and one mowing had no effect on the suppression of growth under growing conditions in Massachusetts. All rates of chemical suppressed seed head formation. There was some discoloration of turf on both grass species with the heavy rate of treatment. There was also some thinning of the sod when the grass was cut in August. This was probably due to sudden exposure of the crowns to the environment by removal of tall vegetation .

The suppression of tall fescue (80%) appears to be ideal for roadside areas or deep rough on golf courses. Even "Baron" Kentucky bluegrass, a short growing species, was reduced in height by about 45% and still produced an attractive sod. With both grass species ½ the recommended rate (20 gallons aper acre) appears to be practical and possibly smaller amounts of Embark might still suppress grass satisfactorily.

[1] D. James Morre, Dept. of Civil Engineering and Dept. of Biological Science, Perdue University, West Lafayette, Indiana

The Average Height (cm) of "Kentucky-31" Tall Fescue and "Baron" Kentucky Bluegrass After Receiving Three Growth Retardant Treatment Rates as Compared to the Check Under Various Maintainance Practices



A. Check Plots

B. ½ Recommended Rate

C. Recommended Rate

D. Twice Recommended Rate

1 inch = 2.5 cm.

FUNGICIDES: THE GOOD, THE BAD, AND THE UGLY

Peter H. Dernoeden
Extension Turfgrass Specialist
University of Maryland

Arriving at the decision of whether to apply a fungicide to any turf area is difficult and generally based on economic considerations. For over 50 years, and prior to the popularization of the IPM concept, turfgrass managers have been fighting diseases through cultural practices. With the advent of modern fungicides, extremely reliable control has been achieved for many turf diseases. Effective chemical control, however, hinges upon a rapid and accurate disease diagnosis. As a group, golf course superintendents are the most experienced turf managers in the area of disease recognition and control. Homeowners, however, often are unable to diagnose turf diseases, or they recognize a disease problem only after substantial injury has occurred. As a general rule, use of fungicides is discouraged in most homelawn situations because (a) proper diagnosis and proper fungicide selection is difficult, (b) it is generally too late to achieve the economic and aesthetic benefits of a fungicide once extensive injury has occurred, (c) homeowners capable of only dry or granular applications do not have the proper spray equipment or they cannot obtain small amounts of the desired fungicide(s) for the disease situation, and (d) it may be less expensive, and better in the long-run, to overseed a damaged turf area with disease resistant cultivars.

Where extremely high quality turf is required (e.g. golf course putting greens and other professional sports turfs) fungicides or employment of numerous, preventative applications or fungicides for may diseases should be discouraged. Other than economic restraints, reasons why repeated fungicide application may not be desirable include:

1. Fungicides may reduce the population of beneficial microorganisms in the soil.
2. Fungicides may disturb a delicate balance among microorganisms that compete with and antagonize disease causing fungi. This may explain why some diseases recur more rapidly and cause more injury in turfs previously treated with fungicides.
3. Continuous usage of a single fungicide may lead to the development of fungal strains that are fungicide resistant.
4. A fungicide may control one disease, but encourage other diseases.
5. Possible phytotoxic or undesirable hormonal effects.

When used repeatedly, certain fungicides have been shown to enhance thatch accumulation. Benzimidazole fungicides (e.g. Tersan 1991, Bromasan and Duosan) and sulfur containing fungicides such as mancozeb (Dithane M-45), maneb (Tersan LSR), and thiram (Tersan 75 and Spotrete), cause thatch to accumulate by acidifying soil. The effect of these fungicides is indirect, that is they inhibit the thatch decomposition capacity of beneficial microorganisms by lowering soil pH. Cadmium fungicides and iprodione (Chipco 26019) also enhance thatch accumulation. In the case of these latter two compounds, thatch build-up is attributed to direct toxicity of microorganisms that degrade thatch. Fungicides may also contribute to thatch build-up by being toxic to earthworms. Earthworms help reduce thatch by mixing soil with organic matter. Benomyl, mancozeb, anilazine (Dyrene) and chlorothalonil (Daconil) have been shown to be toxic to earthworms.

Turf managers have observed that some diseases may recur in turfs previously treated with fungicides, but not in adjacent untreated areas. Dollar spot is probably the most common disease to exhibit this phenomenon. Data, recently recorded in a test conducted by the University of Maryland, have shown that red thread was more severe in the spring of 1983 in Manhattan perennial ryegrass plots last treated with benomyl in July, 1982. These phenonoma are attributed to non-target effects of fungicides, i.e. the fungicide(s) were toxic to microorganisms which antagonize and help keep disease causing fungi in abeyance.

The development of fungal strains resistant to fungicides has been well documented. Resistant strains of the dollar spot fungus first developed as a result of repeated usage of cadmium based fungicides and benomyl. Thiophanates (e.g. CL 3336, Fungo and Duosan), anilazine, and iprodionne resistant strains of the dollar spot fungus have also been reported. Benomyl resistant strains of fungi causing Fusarium blight and powdery mildew, and iprodione resistant strains of the pink snow mold organism have also been reported. The development of resistant strains of fungi likely occurs in response to a selection process that eventually enables a small, but naturally occurring population of resistant biotypes to predominate in the fungicide-treated turfgrass microenvironment.

Fungicides applied to control one disease, may encourage other diseases. Tests conducted in Maryland have shown that benomyl and maneb can encourage red thread. Benomyl has also been shown to enhance

Helminthosporium leaf spot, Pythium blight and superficial fairy rings. Thiophanate-methyl may increase crown rust in perennial ryegrass, iprodione can increase yellow tuft, and maneb may enhance dollar spot. In 1983, in University of Maryland tests, two common-type Kentucky bluegrass cultivars treated on monthly intervals with chlorothalonil were injured more severely by Fusarium blight and heat and drought stress than untreated turf. Encouragement of disease in these situations may again be attributed to offsetting the delicate balance between antagonistic and pathogenic microorganisms in the ecosystem. It is also conceivable that some fungicides may physiologically alter the capacity of a plant to resist a particular pathogen or withstand environmental stress.

The phytotoxicity that accompanies the usage of some fungicides is generally not severe. Most phytotoxicity problems occur when fungicides are applied to bentgrasses, particularly during periods of high temperature stress. Fungicides that can cause yellowing of bentgrass include benomyl, cycloheximide (Actidione), PCNB (Terracolor and Actidione RS) and the mercurials (e.g. Calo Clor and PMAS). Benomyl has been reported to inhibit growth and stolon production in bentgrass, and may cause a tip dieback in Merion Kentucky bluegrass. Etaconazole (Banner and Vanguard), fenarimol (Rubigan), triadimefon (Bayleton) and PMAS treated bentgrass may develop an objectionable blue-green color if used repeatedly or when applied at high rates. PCNB also may elicit a purplish color when applied to Tufcote bermudagrass in the autumn.

It should be noted that many of the harmful side effects just described were either isolated events or occurred only after repeated use of one fungicide over the course of a year or more. Experienced turfgrass managers have long recognized that tank mixing fungicides and rotating fungicides greatly minimizes these potential problems. The importance of rapid and accurate disease diagnosis, and the judicious use of fungicides are integral management programs where fungicides are commonly employed.

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